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The influence of 10-day proprioceptive training on the FMS test results in young female volleyball players – a pilot study

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Abstract

Introduction. Effective preventive measures are necessary not only to reduce the incidence of injuries in volleyball, but also to reduce the costs caused by these injuries. Aim of Study. The aim of the study was to investigate the impact of 10-day proprioceptive training on the results of the functional movement screen FMS in young female volleyball players. Material and Methods. The study was conducted in a group of twelve female volleyball players. The training was performed daily in the form of a circuit for 10 consecutive days. The FMS test was run three times. The first two trials, in one week interval, were conducted before the start of the proprioceptive training. The third assessment was carried out after the completion of 10-day proprioceptive training. Results. The analysis showed differences between studied measurements: first and third as well as second and third ($p \leq 0.001$) in the following FMS test trials: deep squat, hurdle squat, push-ups and rotational trunk stability. Based on mean values of the overall FMS test score, an improvement was observed after the application of 10-day proprioceptive training ($p \leq 0.001$). The study showed that the number of asymmetries found in the FMS test decreased by 50% after the application of the training. Conclusions. The applied proprioceptive training positively influenced the number of points obtained in the FMS test. It also reduced the number of asymmetries and caused that all of the subjects obtained the total FMS test results of ≥17, which is believed to reduce the likelihood of injury. Research results indicate that proprioceptive training should be taken into account by volleyball coaches in daily training.

KEYWORDS: Functional Movement Screen, asymmetry, injury prevention, adolescent, volleyball.

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Introduction

Volleyball is a discipline in which there are many motor activities such as jumps, attacks, blocks, landings and defence. These activities, combined with high game dynamics, require a high level of preparation of the musculoskeletal system, which is exposed to numerous possible injuries [4]. Acute traumas and burdens, both occurring in volleyball, affect joints, mainly ankle, knee and shoulder. The most commonly mentioned injury risk factors include: gender (women vs males), age (adults vs children), nature of the activity (match vs training) [16].

Effective preventive measures are necessary not only to reduce the incidence of injuries in volleyball, but also to reduce the costs caused by these injuries [16]. Among methods of preventing injuries, warm-up, stretching and special training programs of a resistance, isometric, plyometric or proprioceptive nature are the most commonly mentioned [2, 8, 27, 28].

There is no homogeneous nomenclature defining a training program fixed to reduce the risk of injury by improving stability [17]. Some authors call this method balance or stability training [9, 12], others neuromuscular or proprioceptive training [3, 26]. Some authors use the term sensorimotor training [11]. Despite many names in use,

the term "proprioceptive training" will be used later in the text to describe a training method primarily aimed at improving stability. It focuses on the use of somatosensory signals, such as proprioception or stimulation of afferent cells. The aim of the training is to improve or restore the sensorimotor function [1].

The literature has described many proprioceptive training programs supplemented with elements of balance, strength, plyometrics and exercises specific to a sport discipline. They were found to improve balance, coordination and postural stability, as well as to reduce incidence of injuries and pain syndromes in the lumbosacral area [10, 20, 22, 23].

The Functional Movement Screen (FMS) provides a comprehensive analysis of basic movement patterns. It indicates possible constraints or asymmetries in the performed patterns. This test is also used to assess the level of pain, muscle strength, lower limbs joint stability and muscles' elasticity, balance and proprioception [5, 21]. FMS is also used as a predictor of injury. Studies have shown that athletes achieving the FMS test score of less than 14 points were more likely to suffer from injury than those who reached more than 14 points [7, 13]. Another study indicates that asymmetries occurring in particular exercises of the FMS test doubles the risk of injury [14].

Previous studies conducted on a group of volleyball players have concerned the effects of proprioceptive training on reducing injuries and costs of the ankle joint treatment [25, 27]. The effect of proprioceptive training on the results of the FMS test in the group of volleyball players had not been previously described.

Regardless of the sport level, preventing injuries is one of the most important goals in sports medicine and physiotherapy [19].

Aim of Study

The objective of this study was to examine the impact of 10-day proprioceptive training on the results of the functional movement screen FMS in young female volleyball players. The research hypothesis is that proprioceptive training contributes to increased number of points obtained in the functional movement screen FMS and reduced number of asymmetries.

Material and Methods

The study was conducted in a group of twelve female volleyball players practicing 6 hours per week in a sports club. The biometric characteristics of the tested group are presented in Table 1. The subjects were informed of the purpose and the course of the procedure, and they agreed to participate in the study. The entire procedure was carried out in accordance with the Helsinki Declaration.

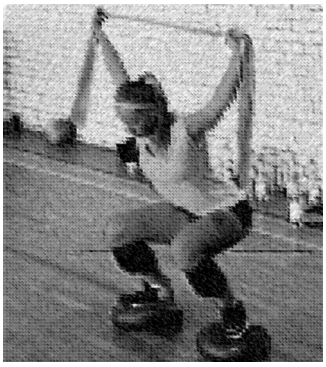
Table 1. Biometric characteristics of the tested group (n = 12)

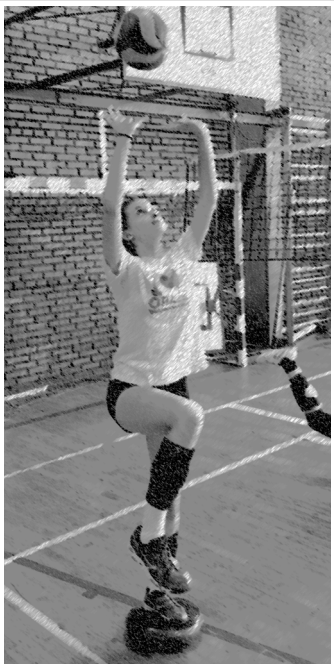
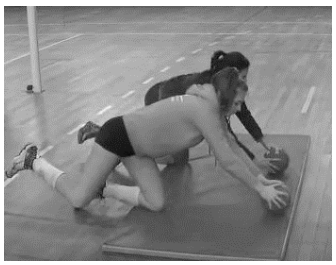
Feature	Mean ± SD
Age (years)	15.17 ± 0.95
Body height (cm)	168.08 ± 5.09
Body weight (kg)	58.83 ± 7.25
BMI (kg/m^2)	20.73 ± 2.16
Training experience (years)	3.29 ± 1.05

The subjects performed the FMS test three times. The first two trials were conducted before the start of proprioceptive training (with one week interval between tests). The third assessment was conducted after completion of 10-day proprioceptive training. All measurements were made by two independent experts. The results in Tables 1 and 3 are averaged values from two independent test.

Proprioceptive training was carried out daily in the form of circuit training for 10 days. The circuit of six exercises (Table 2) was repeated 4 times with two--minute breaks in between. The work time at each of the six circuit stations was 45 seconds. 10-second breaks between exercises were accepted to change the station.

Table 2. Exercises included in the applied proprioceptive training

No	Description	Illustration
1.	Deep squat on balance disks with rehabilitation rubbers.	
2.	Push-ups with legs on a body ball.	

3.	Bouncing the ball with two hands up while standing on one leg on a balance disk.	
4.	Moving alternately the upper limbs while lying face down on a body ball.	
5.	Transferring a medicine ball from over the head onto a mattress kneeling on one leg.	
6.	Marching along a line while doing bend-overs to markers located on the ground.	

Statistical analysis of the obtained results was conducted using STATISTICA 10 software. The Shapiro–Wilk test was used to check the normality of distributions in the examined groups. ANOVA test was used for variance analysis. The Scheffé post-hoc test was applied to examine the obtained results.

Results

All results are presented in Table 3. These results indicate the differences between the successive measurements of the triple FMS in the following tests: deep squat, in-line lunge ($p \leq 0.05$), push-up ($p \leq 0.01$) and rotational stability of the trunk ($p \leq 0.001$). The analysis revealed differences between the first and the third measurement and the second and the third one ($p \leq 0.001$). No differences were found between the first and the second measurement.
Based on the mean values of the overall FMS test score an improvement in the FMS score was observed after the 10-day proprioceptive training ($p \leq 0.001$).
The investigation showed that after 10-day proprioception training, the number of asymmetries found in the FMS test decreased by 50% (from 14 to 7) in the tested group.

Table 3. Results of the triple FMS test (n = 12)

Trial		FMS test result		
		First	Second	Third
		Mean ± SD	Mean ± SD	Mean ±SD
Deep squat		1.83 ± 0.52	1.83 ± 0.52	2.33 ± 0.39 *
Hurdle step	R	2.50 ± 0.52	2.50 ± 0.52	2.75 ± 0.45
	L	2.25 ± 0.45	2.25 ± 0.45	2.50 ± 0.52
In-line lunge	R	2.66 ± 0.49	2.66 ±0.49	3.00 ± 0,00 *
	L	2.75 ± 0.45	2.75 ± 0.45	3.00 ± 0,00 *
Shoulder mobility	L	2.83 ± 0.39	2.83 ± 0.39	2.92 ± 0.29
Trunk stability push up		1.42 ± 0.67	1.42 ± 0.67	2.00 ± 0.95 **
Rotational stability	R	1.25 ± 0.45	1.25 ± 0.45	1.92 ± 0.29 ***
	L	1.33 ± 0.49	1.33 ± 0.49	1.92 ± 0.29 ***
Total FMS test (mean of all trials)		2.37 ± 0.76	2.37 ± 0.76	2.65 ± 0.57 ***
Total FMS test (mean of total FMS scores)		15.58 ± 1.16	15.58 ± 1,16	18.00 ± 0.95 ***
Asymmetries (mean for one person)		1.17 ± 0.94	1.17 ± 0.94	0.58 ± 0.90

first – initial FMS tests; second – FMS test after a week; third – FMS test after proprioceptive training (10 days after the second FMS test); R – right; L – left
Statistical differences between measurements: third to first and third to second; * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

Discussion

The aim of the study was to assess the impact of 10-day proprioception training on the results of the FMS test in

young female volleyball players aged 14-16 years. The literature review has not revealed previous publications on the impact of proprioception training on the results of the FMS test.

The obtained results show that the applied proprioception training improved the results of the following FMS tests: deep squat, hurdle squat, push-ups and rotational stability of the trunk as well as the overall FMS test result.

The mean FMS test result prior to proprioception training was 15.58 points and was lower than the results obtained in a group of 14-year-old volleyball players – 16.3 points or in the adult population – 15.7 points [24]. A lower result of the FMS test of the examined group may be due to the heterogeneous age of the players (14-16 years old) and a lower fitness level compared to the previously tested groups.

In the first and the second measurements, 25% of female volleyball players achieved a total score of the FMS of ≤14 points. Analysis of previous studies shows that the number of results of less than 14 points in the studied groups ranged between 20-31% [15, 18, 19, 24]. The result obtained in the present study is identical with previous reports.

10-day proprioceptive training caused that all obtained results were >14 points. A study by Kiesel et al. [15] indicates that subjects with a total score of the FMS test ≤14 points are 17.7 times more likely to sustain an injury than subjects with results >14 points.

However, research by Letafatkar et al. [18] suggests that subjects who score <17 points in the FMS test are 4.7 times more likely to have a lower limb injury than those with a score >17 points. In this study, before the start of proprioceptive training, 75% of the subjects scored less than 17 points. After 10 days of proprioceptive training, all scores were ≥17 points. This shows that implementation of proprioception elements is necessary in daily volleyball training to increase the FMS test result and thus to reduce a risk of injury.

Chalmers's et al. [6] showed that the presence of one or more asymmetries was associated with a moderate increase in the risk of injury (1.5 times higher risk), while the number of over two asymmetries increased this risk by 3.7 times. In the presented study, before participating in the training the two or more asymmetries were found in 33.3% of the subjects, and 1 or more in 75% of the subjects. After 10 days of proprioceptive training, the number of ≥2 asymmetries were found in 8.3% and of ≥1 in 41.7% of studied athletes.

Based on the obtained results, it can be concluded that 10-day proprioceptive training affects the results of the FMS test, reduces the number of asymmetries and reduces a risk of injuries. Previous papers indicate that such training also improves balance, coordination, postural stability and reduces pain syndromes in the lumbosacral segment [10, 20, 22, 23].

This study was a pilot study. It should be remembered that the obtained results relate to a group of young female volleyball players. Therefore, they cannot be applied to the entire population or other sport disciplines. Thus, further assessment of the impact of proprioceptive training on the results of the FMS test and other functional tests is indispensable.

The subject of subsequent studies should be the application of proprioceptive training in different groups (other sports disciplines, subjects of different age and gender), extension of the duration of proprioceptive training to 3-6 months, increasing the number of subjects, determining the injury occurrence before and after the intervention and using more tests assessing motor skills and functional parameters of the studied group.

Conclusions

The applied proprioceptive training increased the number of points obtained in the FMS test. It also reduced the number of asymmetries in the tested group and led to obtain a total result of the FMS of ≥17 points in all subjects. This states a positive prognosis in order to reduce the likelihood of injury. Research results indicate that proprioceptive training should be taken into account by volleyball coaches in daily training.

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